Effect of physically contained greenhouse covered by fine mesh on pollen dispersal in maize

Shin Watanabe, Hiroshi Kamada, Hiroshi Ezura
Gene Research Center, University of Tsukuba, Tsukuba-shi, Ibaraki-ken, 305-8572, Japan

Abstract. **The risk from genetically modified (GM) plants results from the possibility of gene contamination producing adverse effects on biological diversity by introducing herbicide or insect resistance into related plants or weeds (NAS 2002). The concern about the leakage of genes from GM plants into the environment has primarily focused on pollen that could be wind-borne for long distances. During the period of risk assessment in Japan, physical containment is applied as a measure of reducing gene flow via the dispersal of pollen from GM plants into the surrounding environment. In this study, we tried to estimate the effect of physically contained greenhouse covered by 1-mm fine mesh to reduce pollen dispersal by researching cross pollination rate between non-GM yellow maize in a greenhouse and silver maize outside the greenhouse.**

Introduction

Maize (*Zea mays* L.) is not only one of the world's important crops, but also one of crops in which the leakage of genes via pollen into the environment is concerned because GM maize occupies the 2nd largest cultivated area (19.3 million hectares 23% of global GM crop area) in worldwide GM crop species (ISAAA 2004). Moreover, maize has xenia effect that is defined as the effect of the genes via pollen from the male parent on the development of the fruit or the seeds; hence it is possible to investigate dispersal movement of pollen in maize without using GM maize. The purpose of this practical scale experiment was to investigate the effect for reducing pollen dispersal of non-GM maize in physically contained greenhouse where all the openings are covered by 1-mm fine mesh (provided biosafety regulation by Japanese government).

Materials and Methods

Zea mays cv. honey bantam with yellow kernel (yellow maize) was used as the pollen donor and the samevariety with silver kernel (silver maize) was used as the seed donor. The experiment was performed at experimental field near University of Tsukuba in Tsukuba, Ibaraki, Japan. The yellow maize were sown on May 17, 22, 27, 2004 in a 6.0-by 7.6-m square in a 40-by 37-m field (Figure 1). The area surrounding this central plot was sown with the silver maize at May 22, 2004. All plants were sown in rows at

intervals of about 0.75 m with a distance of about 0.3 m between the single plants. Meteorological data including air temperature, luminous intensity, precipitation, wind speed and direction of the experimental field during the experimental period were collected by weather station equipped with a Vantage Pro (Davis Instruments Co, U.S.). On July 1, 2004, just before the yellow maize's tassel (male flower) open, a pipe flame-greenhouse (W: D: H = 6.3: 7.65: 2.8 m) covered by 1-mm nylon fine mesh was set to surround yellow maize growing area. The growth data was collected at least once per a month. The flowering condition data both male and female flower was collected once a week after flowering started in July. After the silver maize fruits were sampled on August 3, 2004, the both number of yellow and total kernel were counted on each fruit to calculate the cross pollination rate with the formula described below.

Cross pollination rate (%)= {number of yellow kernel / (row number x line number of fruit)} x 100

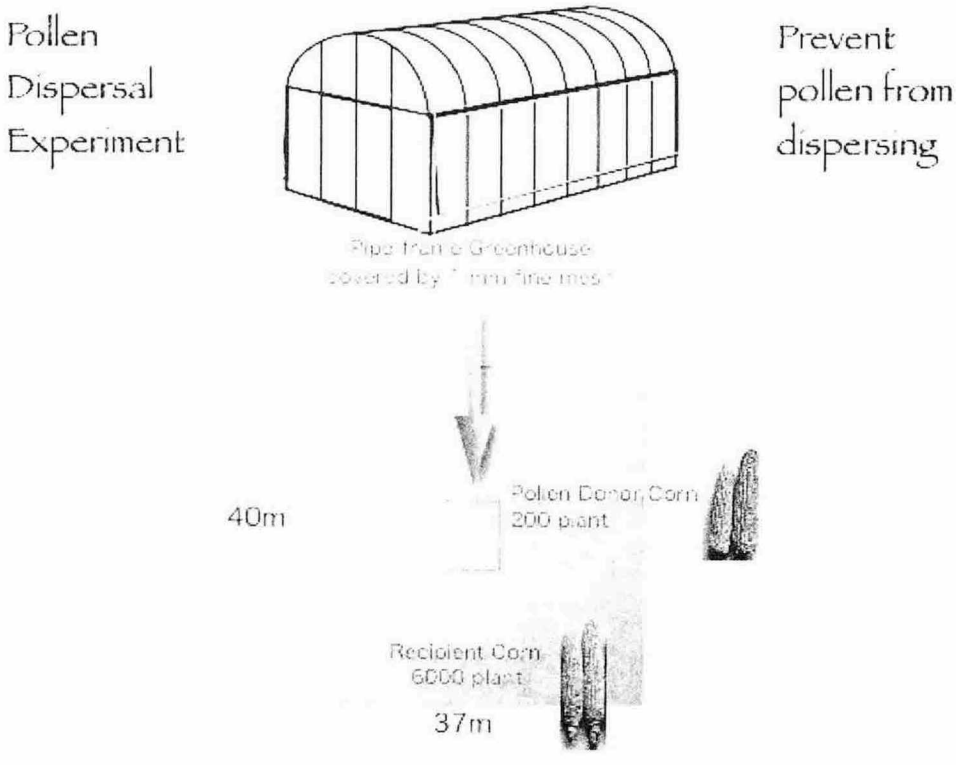

Figure 1.

Results and Discussion

There was little precipitation during rainy season (June and July) of 2004 around experimental area. The wind direction changed on daily basis and the average wind speed was approximately 3.0 m. The plants grew to an average height of 1.5 m in yellow maize

and 1.0 m in silver maize. The results indicated that it was easierfor pollen disperse in yellow maize than in silver maize. The corn ear was located in the middle between 0.2 m and 0.8 m. The male and female flower both yellow and silver maize blossomed between July and the beginning of August. The average cross pollination rate of silver maize adjacent to yellow maize was 32.8%. The cross pollination rate decreased with the distance between yellow maize and silver maize increased and at 6.3 m apart from yellow maize, the cross pollination rate was 1.0 %. In similar previous experiments operated by National Institute for Agro-Environmental Sciences in Japan, The average cross pollination rate of silver maize which was below 3.0 % at 18 m and 1.0 % at 36 m apart from yellow maize (Matsuo et al. 2004). Though it is not possible to compare the result of this study with other result, though the experimental design was similar, our result indicated that physically contained measure using 1-mm fine mesh was effective to reduce amount of pollen dispersal from greenhouse.

Acknowledgement

This study was supported by a Research Grant of the Life Science Program from the Ministry of Education, Culture, Sports, Science and Technology (MEXT; Japan).

Literature Cited

ISAAA (International Service for the Acquisition of Agri-Biotech Applications)(2004) Worldwide Biotech Crops Experience Near Record Growth. ISAAA Briefs 32-2004: Global Status of Commercialized Biotech/GM Crops 2004 Executive summary

Matsuo K, Kawashima S, Mori A, Saito O, Matsui M, Otsu K, Oguro T, Matsumura O, Mitamura T (2004) Research on cross pollination and pollen dispersal from GM crops. The Bull. of National Institute for Agro-Environ. Sci. 12F10: 82-83

NAS (National Academy of Science, USA) (2002) Environmental Effects of Transgenic Plants: The Scope and Adequacy of Regulation. National Academic Press, Washington, DC, USA, p. 320.

Shin Watanabe

Present Address:
Gene Research Center, University of Tsukuba
1-1-1 Tennodai, Tsukuba-shi, Ibaraki-ken, 305-8572, Japan

E-mail: nabeshin@gene.tsukuba.ac.jp

Education:

Ph.D. 2002	University of Tokyo (Forestry), Tokyo, Japan
M.S. 1996	University of Tokyo (Forestry), Tokyo, Japan
B.S. 1994	Miyazaki University (Forestry), Miyazaki, Japan

Professional Experience
2003-Present Postdoctoral fellowship University of Tsukuba (Molecular Biology), Tsukuba, Japan
2000-2003 Institute of Environmental Science CATS Co. (Environmental Science), Toride, Japan

Publications

1. H. Shen, S. Watanabe, Y. Ide, (1998) Establishment of a callus culture system of *Populus euphratica, Populus alba* cv. maximowiczii × *Populus plantierensis*. Bull. Tokyo Univ. For. : 100, 19-26
2. Y. Ide, S. Watanabe, S. Shiraish, Y. Saito, T. Tanimoto, H. Shen (1999) "*Populus euphratica*" a promissing gene resource for semi-arid regions. Proc. Inter. Symp. "Can Biological Production Harmonize with Environment ? " 181-184
3. S. Watanabe, K. Kojima, Y. Ide and S. Sasaki (1999) Establishment of a tissue culture system of *Populus euphratica* Oliv. Bull. Tokyo Univ. For. :102, 87-92
4. H. Shen, S. Watanabe and Y. Ide, (1999) Growth of suspension cultured cell of Populus euphratica, *Populus alba* cv. Pyramidalis and *Populus maximowiczii* × *Populus plantierensisin* NaCl containing medium. Bull. Tokyo Univ. For. : 102, 143-150
5. S. Watanabe, K. Kojima, Y. Ide and S. Sasaki (2000) Effect of saline and osmotic stress on proline and sugar accumulation in *Populus euphratica* Oliv. in vitro. Plant cell, Tissue, and Organ Cul. 63 : 199-206
6. Y. Saito, S. Shiraishi, T. Tanimoto, S. Watanabe, Y. Ide (2002) Genetic Diversity of *Populus euphratica* Populations in Northwestern China Determined by RAPD DNA Analysis. New Forests 23: 97-103
7. S. Watanabe, H. Kamada, H. Ezura (2006) Reducing gene flow from pollen dispersal of GM plants in physically contained greenhouse. Plant Biotech. (under contribution)